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The objectives of this grant are to delineate and to better understand oscillations in ionospheric structure which occur at planetary-wave periods (i.e., 2-10 days). Effort has concentrated on analyses of about 30 years' of archived ionosonde data from a global array of stations, and some satellite-based measurements of total electron content. The study has produced statistics concerning amplitude variability, season dependence and longitudinal structure pertaining to the quasi two-day oscillation. The P.I. has also formulated some theories concerning the physical origin of the quasi two-day ionospheric oscillation.

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FINAL REPORT

"Planetary Waves in the Ionosphere"
Grant F49620-95-1-0118

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February 15, 1998

Objectives and Overview: The objectives of this grant are to delineate and better understand oscillations in ionospheric structure which occur at planetary-wave periods (i.e., 2-10 days). Effort has concentrated on analyses of about 30 years' of archived ionosonde data from a global array of stations, and some satellite-based measurements of total electron content. The study has produced statistics concerning amplitude variability, seasonal dependence and longitudinal structure pertaining to the quasi two-day oscillation. The P.I. has also formulated some theories concerning the physical origin of the quasi-two-day ionospheric oscillation. Results of this work have been published in one M.S. Thesis and four journal articles. In addition, reporting work completed under previous AFOSR Grant F49620-92-J-0092, an additional journal article involving the simulation of the global transport and localized layering of metallic ions was submitted and accepted for publication.

Summary of Accomplishments/New Findings: This research has quantitatively documented the quasi-two-day ionospheric oscillation, and has connected this oscillation with the "2-day wave" known to exist in the stratosphere and mesosphere. The oscillation is shown to usually occur with amplitudes in the range ± 0.4-1.0 Mhz superimposed on a background of order 10.0 Mhz. Zonal wavenumber characteristics (i.e., longitude dependence) and seasonal occurrence frequencies have also been quantified. This information will now permit some measure of predictability of this phenomenon, which represents one of the components of "space weather" which originate in the lower atmosphere. Although unexplored to date, similar variations are likely to

occurr in radio interference phenomena such as scintillation. The work on metallic ions is the first to self-consistently model the sequence of meteoric deposition of metals (i.e., Fe and Fe^+), global transport in the F-region due to winds and electric fields, the formation of thin high-density descending layers in the E-region, and chemical destruction below 100 km.

The relevance of this work is that it represents one step in understanding the causes of variability in fidelity of communications which transit the ionosphere. Understanding the causes and likelihood of ionospheric variability will allow military and civilian users to choose communications options or pathways that minimize ionospheric degradation.

Personnel: Personnel supported under the grant include the P.I. (faculty member), and the following graduate students: R. Guffee, X. Zhang, D. Revelle and M. Angelats Coll.

Publications: The following publications have resulted from the research effort:

Guffee, R., "Quasi 2-Day Wave in the Ionospheric F-Region, Thesis submitted in partial fulfillment of the requirements for the Master of Science, Department of Aerospace Engineering Sciences, University of Colorado at Boulder, 1995.

Forbes, J.M., "Planetary Waves in the Thermosphere-Ionosphere System", J. *Geomagnetism and Geoelectricity*, *48*, 91-98, 1996.

J.M. Forbes, R. Guffee, X. Zhang, D. Fritts, D. Riggin, A. Manson, C. Meek and R.A. Vincent, "Quasi 2-day oscillation of the ionosphere during the summer of 1992, *Journal of Geophysical Research*, *102*, 7301-7305, 1997.

J.M. Forbes and X. Zhang, "Quasi 2-day oscillation of the ionosphere: A statistical study", *Journal of Atmospheric and Solar-Terrestrial Physics*, *59*, 1025-1034, 1997.

J.M. Forbes, D. Revelle, X. Zhang and R.E. Markin, "Longitude structure of the ionosphere F-region from TOPEX/Poseidon and ground-based data during January 20-30, 1993, Including the quasi-two-day oscillation", *Journal of Geophysical Research*, *102*, 7293-7299, 1996.

Carter, L.N., and J.M. Forbes, Global transport and localized layering of metallic ions in the upper atmosphere, Ann. Geophys., in press, 1998.

Interactions/transitions: The following presentations have been made at conferences:

Forbes, J.M., "Planetary Waves Influences on the Ionosphere", invited review presented at the IUGG XXI General Assembly, Boulder, Colorado, July 5-19, 1995.

Forbes, J.M., "Longitude structure of the ionosphere F-region from TOPEX/Poseidon and ground-based data during January 20-30, 1993, Including the quasi-two-day oscillation", COSPAR Meeting, Birmingham England, July, 1996.

New discoveries, inventions, patents: None

Honors/Awards: None